GEM & AME

Generalized Emulation of Microcircuits
Advanced Microcircuit Emulation
Presentation

DSCC 2003
Supplier Conference
& Exhibition

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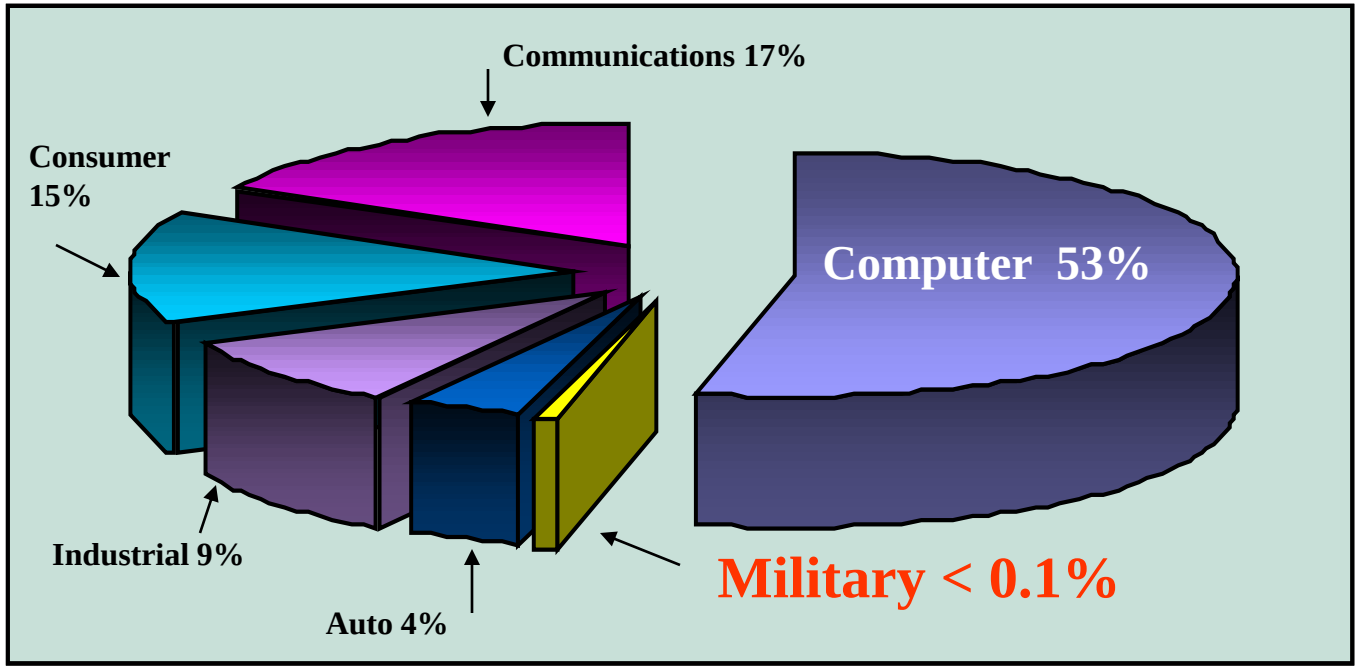
AGENDA

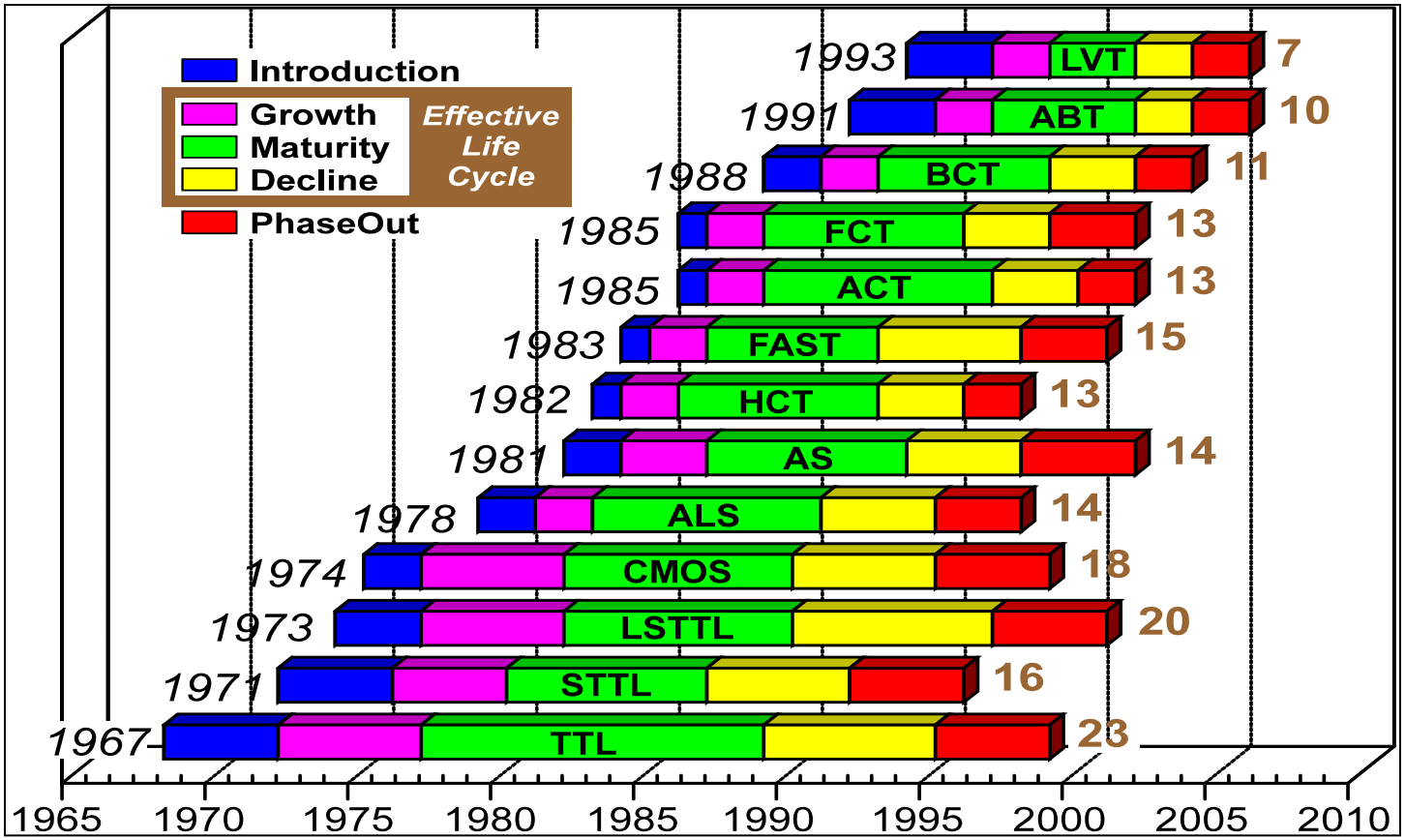
- Microcircuit Obsolescence & Weapon System Life Cycles
- What is Microcircuit Emulation
- GEM Program Brief
- AME Program Brief
- Questions

$200B Global Semiconductor Market

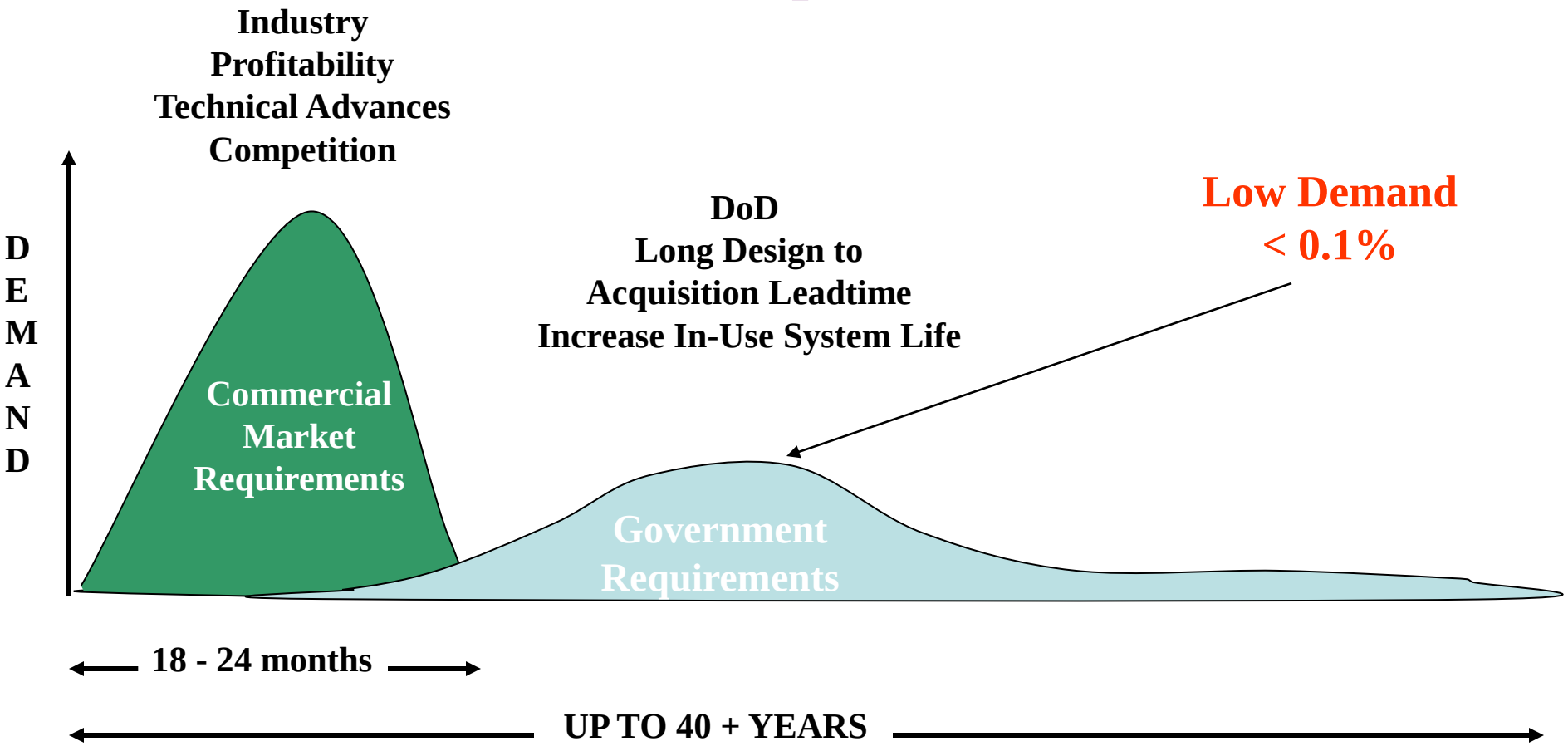
- Microcircuits (Digital, Analog, RF) are major functional components of Weapon Systems
- IC Industry abandoning Military Market - Since 1995 Motorola, Intel, AMD, Philips,
- Military share of semiconductor market is <0.1%
- Military requires many non-standard Application Specific Integrated Circuits
- IC technology is driven by telecon and computer sectors



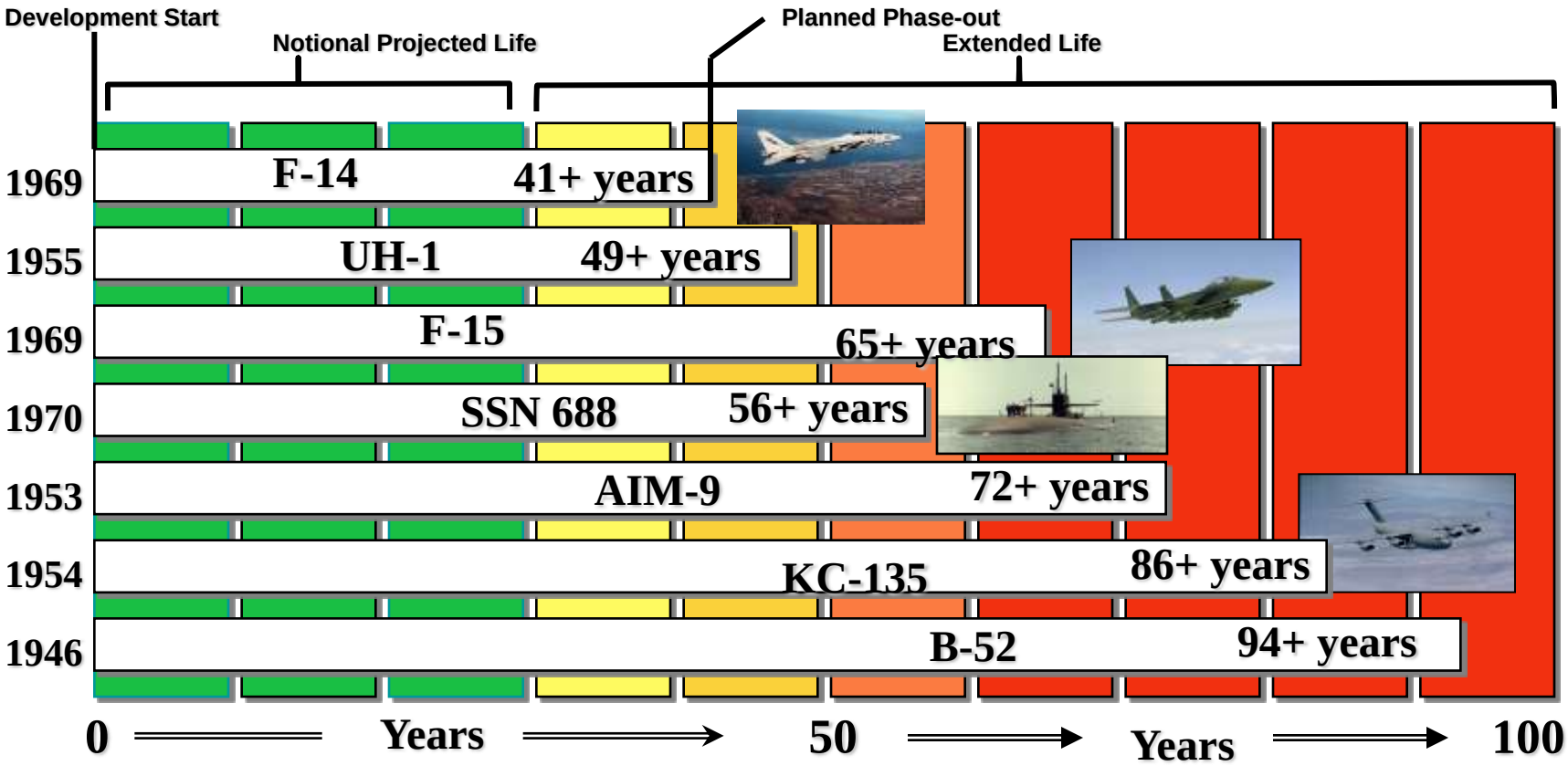
Microcircuit Technology Life Cycle



Government vs. Commercial Market Requirements



Weapons Systems Life Cycle Extension(s)



Source: Department of Defense

What is the Solution ?

- Joint Logistics Commanders chartered the Joint Technical Coordinating Group on Microcircuits (JTCG-MC) in the Mid 80's to analyze the microcircuit support problem - Chartered Study on Microcircuit Obsolescence
  - Develop a "Technological Solution"
  - TRI -Service & DLA "ManTech" Effort
  - Government Sponsored Microcircuit Emulation Research and Development was initiated, became Generalized Emulation of Microcircuits in 1987

GEM Contract Status

- DLA Managed / 5 Year R&D Effort (1987 - 1992)
- DLA/DSCC Managed 5 Year Validation Effort (1992 - 1997)
- DSCC Managed Production Contract I (1997-2002)
- DSCC Managed Production Contract II (2002-2007)
- GEM is Operational Today

DSCC-CCD – GEM Program Management Responsibilities

DSCC-PLI – GEM Contracting Function

DSCC Primary Emulation Responsibilities

- Manage / Maintain the GEM Process Capability
- Minimize Circuit Card Assembly Redesign
- Improve DOD Readiness and Supportability Levels.
- Ensure Parts availability for Inventory Control Points, OEM's, Military Services and Federal Agencies
- Educate the military services and OEM community about this existing capability

Emulation Contractor
Sarnoff Corp.

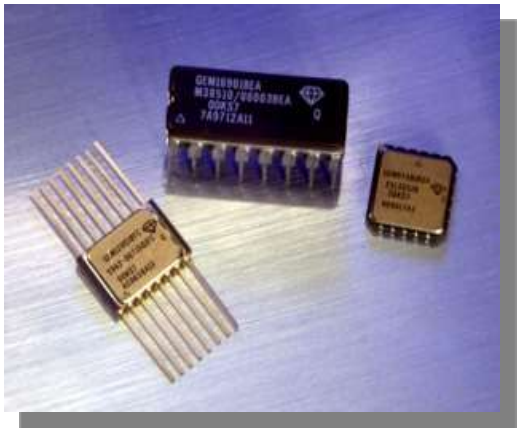
- **Located in Princeton NJ, Cage (0DKS7)**
- **Class Q IC Design and Production**
  - **Extensive in-house microcircuit design and test capability**
- **Class Q IC Foundry**
  - **Low volume manufacturing**
  - **Continuing support from DLA/DSCC**
  - **In-house foundry supporting**
  - **Multiple product lines - GEM/AME, Imagers, Displays & Sensors**
- **Certifications**
  - **Fully QML certified**
  - **Boeing CQS certification for commercial aircraft**

How is Sarnoff's foundry capability different from mainstream foundries ?

	Sarnoff GEM	Prod. Foundry
• Wafer Size Diameter	4 inch	8 to 12 inch
• Fab Capital Investment	~$10M	~$1B
• Wafers Per Month - 4 Inch Equivalents	2 to 4	100,000
• Process Linewidth - μm (Millionths of a Meter)	>1.0	mostly <0.35
• Microcircuit Power Supply Volts	5 v	<3.3 v

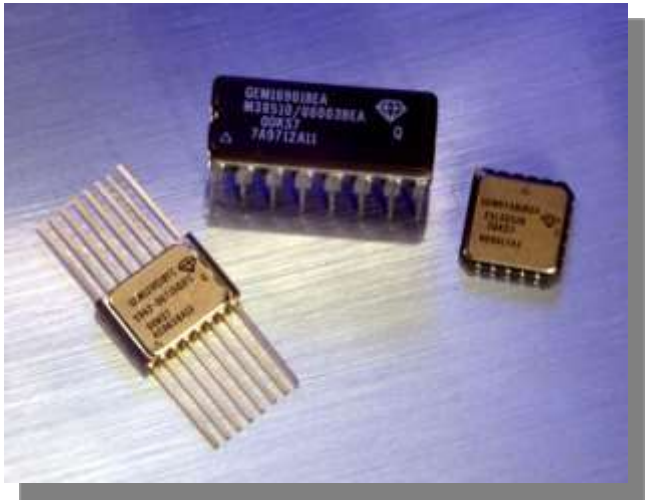
What is Emulation ?

Production of a microcircuit which is:



- Form
  - Same package
  - Same pinout
  - Same marking
- Fit
  - Matches the data sheet and selected
  - item parameters at all temperature and supply voltages
- Function
  - Performs the same function and satisfies the test vector set of the original part

GEM Technology Capability



- GEM technology can support
  - Supply voltage up to 20V
  - Total pin count up to 48
  - Pin-to-pin propagation delay > 5nS
- GEM Technology is flexible
  - Solve Timing Problems
  - Tailored Parameters (when needed)
- Technology Families Supported - RTL, DTL, TTL, LS, H, HC, HCT CMOS & ECL, Borderline Analog (Drivers & Comparators)

GEM Fabrication Line

Si Wafer

BiCMOS Process

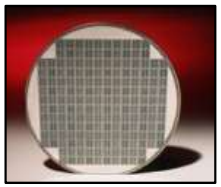
GEM Base Wafer Inventory

Unavailable IC

Reverse Engineering System
Slash Sheet
Data Sheet
Test Vectors

Computer Aided Emulation Design System
Macro Library
VHDL

Personalization Process
2 Level Metal Interconnects



Personalized GEM Wafers

Package Test

Pantronics
QP Labs

IC's Delivered

TTL, DTL, RTL, ECL, CMOS, PMOS, NMOS
Form, Fit, Function

GEM Technology Capability

- Covers over 65 % of the digital ICs in the Federal Supply System
- Sarnoff is a MIL-PRF-38535 (QML) Qualified Source, Provides MIL-Spec, SMD and SCD part types
- GEM can Break the obsolescence cycle - Provide a continuing source of microcircuits, solve the problem one time
- GEM Can help Reduce operating and maintenance (O&M) costs through the avoidance of unnecessary (continuous) redesign cycles due to obsolete microcircuits/ processes
- GEM helps Maintain quality requirements and system readiness with minimal documentation changes

GEM Accomplishments

- GEM has avoided costly Circuit Card Assembly Redesign
- GEM has prevented production line shut downs at Raytheon, Vista Controls and Smiths Industries as well as repair line shutdowns at WR-ALC.
- The GEM Program has supplied over 43,000 devices to DSCC, OEM's and directly to the Military Services.
- DSCC contracts support 312 unique listed weapons systems, eliminating over 635 DSCC backorder lines for 3,654 pieces
- Sarnoff is a fully certified to MIL-PRF-38535 and is currently listed on the QML as a source of supply for > 600 MIL& SMD p/ns.

Air Force

- > 190 GEM Emulation Actions for the F-15
- > 2000 Insertion Tests Completed
- > 215 unique CCAs Supported
- GEM has eliminated repair line shutdowns at Raytheon
- GEM has eliminated items on backorder at DSCC for WR-ALC F-15

- GEM Production Parts flying in F-15 Radars and various support equipment

NAVY

- **AN/UYK-44**
  - **48 Modules - $1200K Avoidance**
  - **Prevented Production Shutdown**
  - **PHALANX also uses**
- **AN/SLQ-32**
  - **1 Circ. Card Asbly. - $150K Avoidance**
  - **Prevented Production Shutdown**
- **AN/SQS-56**
  - **1 Circ. Card Asbly. - $150K Avoidance**
- **AN/SPS-49**
  - **3 Circ. Card Asbly. - $450K Avoidance**
- **AN/UYK-43**
  - **1 Circ. Card Asbly. - $150K**
  - **SQQ-89 also uses**

$4.4M Reported Cost Avoidance

ARMY

- **MLRS**
  - **$2.0M cost avoidance**
  - **Lockheed Martin**

- **BRADLEY FIGHTING VEHICLE**
  - **$700K Cost Avoidance**

$2.7M Reported Cost Avoidance

Who Can Purchase GEM Devices ?

All Military Services,
All Government & Federal Agencies
and ……..

OEMS / Distributors

LOCKHEED MARTIN

SMITHS INDUSTRIES Aerospace

EFW

Rockwell

Litton
Technology.Solutions.Results.

CUBIC DEFENSE SYSTEMS, INC.

GEC-Marconi

VISICOM
A TITAN COMPANY

NORTHROP GRUMMAN

GENERAL DYNAMICS
Strength on Your Side™

luke INTERNATIONAL
electronic component sourcing

BOEING

AlliedSignal

Arrow/Zeus Group

Raytheon EXPECT GREAT THINGS

How to Obtain GEM Parts

- **Through logistics channels**
  - Requisitions to DSCC
- **For MILSVC funded requirements**
  - Military Interdepartmental Purchase Request (MIPR)to DSCC/DLA
  - SOW/RFP Prepared & Coordinated by DSCC/DLA
- **By direct contract with Sarnoff**
  - Applies to Non-Government & Commercial Activities usually OEMs
  - Contract Arrangements between Sarnoff and Customer
- **In NATO aligned European countries & Israel**
  - Contract through Luke International Inc.

GEM Contacts

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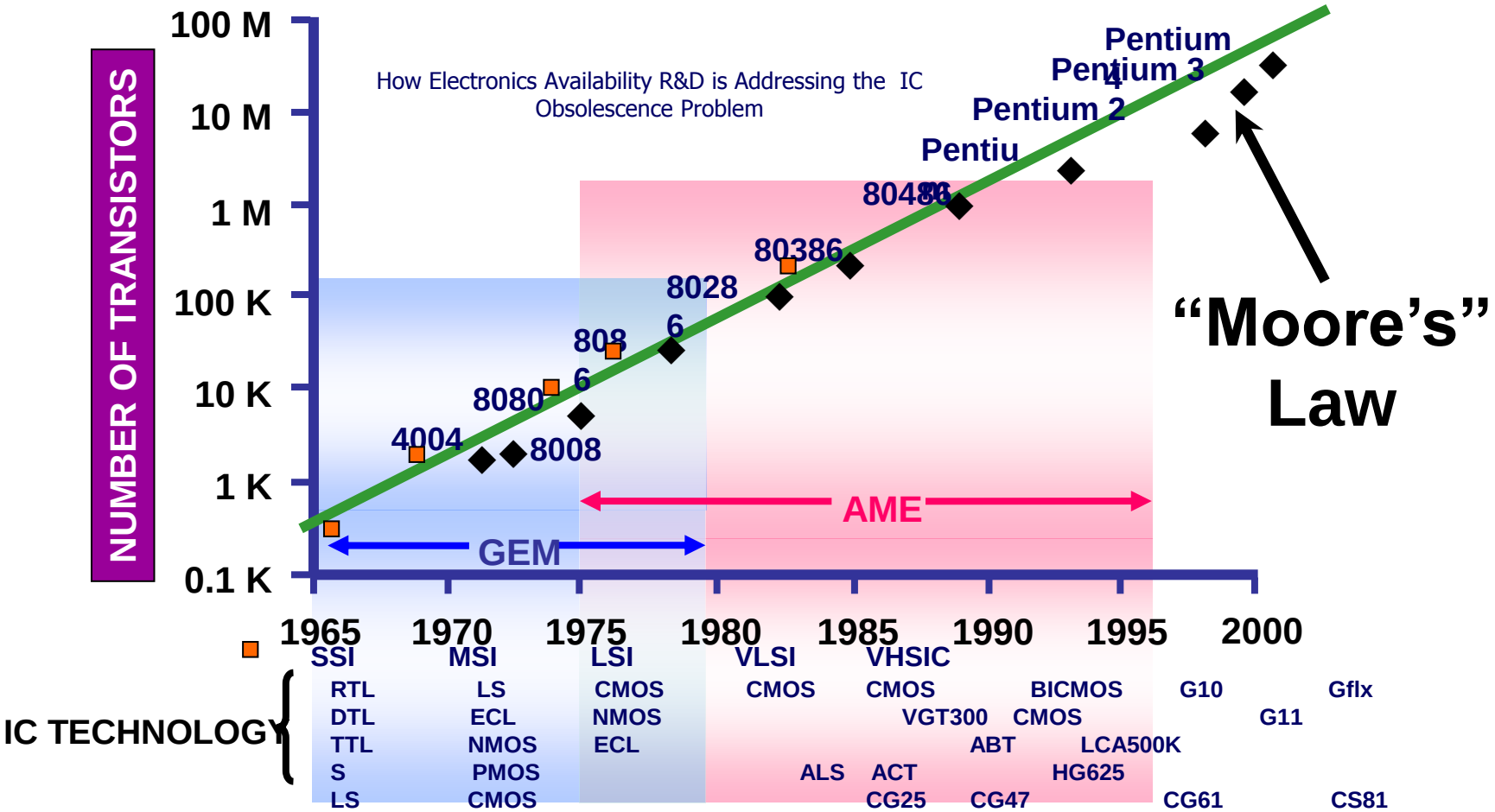
GEM : A Proven Solution

Microcircuit Obsolescence Is Manageable

- **GEM is a Powerful Support Tool**
  - **Delays / Avoids System Redesigns**
  - **Allows Readiness Support During the Introduction of System Upgrades**
  - **Complements Life-of-Type and Bridge Buys**
- **GEM Breaks the Obsolescence Cycle**
- **Identification of Parts Commonality at the SRU / LRU Levels Allows Economy of Scale**

Advanced Microcircuit Emulation (AME) Program

GEM – AME Interrelationship



GEM / AME INTERRELATIONSHIP

- **GEM Program**
  - **Supports pin out ≤ 48 pins**
  - **Most Complex Array – approx 2,500 design gates**
  - **Production / QML**

- **AME Program**
  - **Supports pin out ≤ 256 pins & increasing**
  - **Most Complex Array – approx 220,000 design gates, larger arrays in development**
  - **Research & Development**

AME Overview

- Background
- The Challenge
- Solution Options
- Generic Solution
- Current Status
- Plans
- Conclusion

Background

- Decreasing microcircuit technology family lifetimes
  - Accelerated Industry technology roadmaps
  - Computer and Telecom driving industry
- Capital intensive Fabrication Lines
- Industry turndown / refocus
  - DoD represents small & decreasing segment
    - Industry no longer tracking DoD consumption
  - Aftermarket supporting more commercial segment/product

AME's Challenge

- The non-procurable devices are ever more complex and/or operate at high speeds
- The current obsolete devices are moving away from standard logic families
- Application Specific Integrated Circuits are a growing portion of DMS
- Lack of data: Performance, function, and test
- Analysis for mitigating these advanced devices is altered

Complex Device Solutions

- **Solutions: Redesign, Substitution, Scavenge, Remanufacture, Retirement, & Emulation**
- **Board Redesign is more expensive and complex as the functional complexity increases**
- **Component options for redesign are limited as complexity increases**
  - **Replacement component production lifecycle is also decreasing**
  - **Short term availability institutionalizes obsolescence cycle and raises lifecycle support costs**

Remanufacture

- **Remanufacture is producing the original non-procurable device after original production has ceased**
  - **Device produced using same technology & fabrication process as the original device**
  - **Requires access to the original production data, data rights, & similar equipment**
  - **Usually a time delay for implementation of technology to make the original device**

AME Emulation

- **Emulation uses existing, proven Generic (non-proprietary) technology to produce a Form, Fit, and Function equivalent device**
- **Requires no:**
  - **Data rights**
  - **Time lag or funding to implement or re-implement the technology (Technology Transfer)**
  - **Access to obsolete materials or equipment**
- **Provides a long term, economical solution**
  - **Available now, available in the future**

Advanced Microcircuit Emulation (AME) Program

- **Objective: Develop & demonstrate Advanced Microcircuit Emulation technology that provides an ongoing rapid, economical, high quality microcircuit emulation capability to support the non-procurable requirements of inventory control points, OEMs, and weapon systems**
- **Awarded: Sarnoff Corp., Princeton, NJ**

AME Implementation

- **Scope: Advanced digital devices, microprocessors/microcontrollers, analog, hybrids, memory, engineering services on assemblies using AME technology elements**

- **Mitigate the microcircuit DMSMS impact**
  - **Requests for non-procurable microcircuits beyond current GEM emulation capability**
  - **Surveyed ICP, Weapon Systems, and DoD community for requirements**

Why AME through DLA?

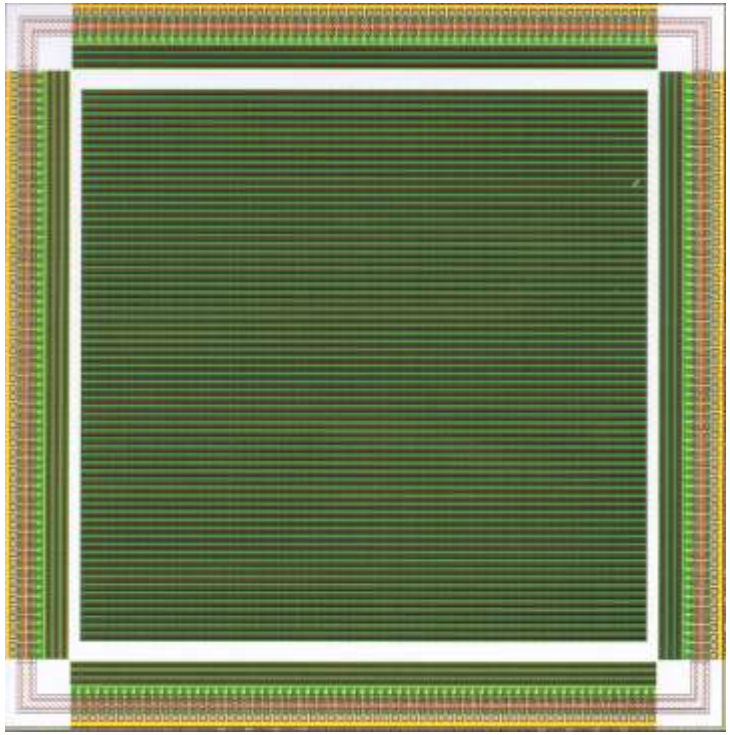
- **Defense Supply Center, Columbus (DSCC) is the DoD's Microcircuit Inventory Control Point (ICP) Manages >88% of microcircuits**

- **Support to Warfighters is essential,**
  - **DLA business goal to be supplier of choice**

- **Unfilled Purchase Requests:**
  - **Decreased mission readiness**
  - **Increased Costs to Customer & taxpayer**

AME Technology

- Gate Array & Sea of Gates Technology
- Commercial design and fabrication equipment
- Scalable design libraries
- Mil Quality Program implementation
- In-house fabrication line
- Related Bipolar, CMOS, BiCMOS fab processes
- Successive technology releases



220K Sea of Gates Array

AME Status

- 1.2µ & 0.8µ emulation processes developed
- 0.65µ & 0.5µ emulation processes in development – allow higher performance
- Triple level metal process successfully implemented
- Class Q certification for early AME technologies achieved
- Numerous Arrays designed
  - Small and large arrays for technology
  - Completed design of 500K Gate Array

AME Status (cont)

- Numerous Customers
  - Including: F-15 (Multiple), C-17, A-10, Phalanx, B-52, F-22, Harrier, Joint STARS, Comanche
- Devices successfully fabricated in 220K Array
- Initiated Analog emulation
- Continuing larger array design
- AME Design System proven & continues expanding capability

Emulation Advantages

- Solve a DMSMS situation one time
- Breaks the obsolescence cycle
- Flexible technology
  - Accommodates small volume
  - Can be tailored
- No required changes to documentation or test programs
- Reduces unneeded redesign
  - Redesign for performance not obsolescence

AME Plans

- Proceed to gate lengths at 0.5µ
- Design and implement larger arrays
- Expand design library
- Demonstrate technology
- Continue Quality implementation
- Continue implementing analog emulation
- Continue to reduce the cost/gate for microcircuit emulation

AME Contacts

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Conclusion

- **Emulation is an important complementary tool to other means of addressing DMSMS**

- **No single method satisfactorily solves all situations. Emulation offers a long term, rapid, cost effective, high quality solution technology.**